SIGMA XI AND INDUSTRIAL RESEARCH*

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The Society of Sigma Xi stands today in an anomalous position. Its avowed purpose is ambitious; its machinery quite inadequate for that purpose. The function of Sigma Xi is the encouragement of scientific research, but scientific research is no longer monopolized by those academic centers about which the Society was built. The extraordinary development of industrial research, both in quantity and in scientific quality, threatens to leave the sponsor of "zealous research" in the perplexed condition of a motherly hen whose finest and largest eggs hatch into creatures that fulfill their destiny on aqueous stretches not approved by their foster mother. Shall the industrial reasearch ducks be considered as proper material for society activity, with a consequent revision of the society organization, or shall Sigma Xi be content with its original but now restricted field, namely, scientific research in universities?

The necessity for facing new problems, while frequently a nuisance, is the best evidence that growth and development are taking place. In large measure Sigma Xi may take to itself credit for the spread of the ideals of scientific research in this country; consequently the existence of the problem under discussion may be viewed with some complacency. Quite otherwise would it be if the Society were being brought to task for failure, rather than for signal success.

For a proper understanding of the Society's problem, it is desirable to trace the metamorphosis of research in this country since the time of the inception of Sigma Xi. Who then carried on research and why? Who carries it on now and why? Research has been at one time and another the hobby of the scientific amateur who dabbled in it for the gratification of his esthetic or religious sense; the voluntary or required part-time activity of the scientific teacher who must fill in gaps in the body of knowledge he must teach; the continuous and unique occupation of professional researchers employed in research organizations supported either for commercial or philanthropic purposes. Still another class of scientific investigators who have been of enormous influence in this country, cannot be overlooked—the inventors, those one-man research organizations.

*Contributed by invitation.

At the time of the founding of Sigma Xi, scientific research in America was chiefly carried on by two of these groups: the scientific teachers in the universities, and the inventors. Broadly speaking the inventor, in spite of the glory and service he contributes to the country, does not seem to have been thought of as a scientific man at all. In those days he was rarely a university man; he was not a gentleman of leisure; he had to make a living out of his special ability, and was in consequence undoubtedly looked down upon as a selfish money-grabber by many of the teaching group who had exalted ideas of the spiritual quality of pure science. At any rate, Sigma Xi, founded to encourage scientific research, was and still is primarily a university institution.

In the last thirty years a process of shifting and readjustment has taken place. There has been least change in the universities. Research is still considered the legitimate part-time work of the teacher. But with the extreme specialization which has gone on in all science, comes the danger that the really active research man may lose that breadth of view which is more than necessary for the teacher who is responsible for laying the foundation of knowledge. Add to this the competition of the professional research man in supplying the very knowledge the teacher needs and once had to seek for himself, and it is easy to understand its being asked here and there whether research should be expected to the extent it has been from the professional teacher. Research in the universities, to put it conservatively, has not the encouragement to grow that it has in certain other quarters.

Meanwhile the individual inventor has been to a large extent swallowed up by the advances in industrial organization. He is no longer under the necessity of working alone with inadequate facilities; moreover, his opportunity as a free-lance is narrowed. There are fewer chances now for happy accidents. The fields have been plowed over pretty thoroughly. Today he is apt to be a member of the development or research department of a large company.

Here he meets the university man who is a research specialist but has not stayed in the university. Together they make up the industrial group, which in numbers and in the quality of the work turned out, does or soon will exceed all the others in research work, at least in the physical sciences. They are men devoted to the scientific method, doing work of permanent scientific value, keenly interested

in the advancement of science, and valuable public servants. Who would seriously question their equal right to be "zealous companions in research" with the teacher of science?

There has existed a general impression that there is a definite line of demarcation between pure scientific research and industrial research, whereby one is scientific and the other merely commercial—that scientific research has no practical end in view, and that industrial research is solely for practical ends. This differentiation, were it true, has been supposed to carry with it a reproach upon things practical. Such a viewpoint, a relic of days when science was the monopoly of the "gentleman" who looked askance at the "shopkeeper," is surely out of place in the country which produced Franklin and Edison; out of place especially at a time when conservation of our natural resources—achieved only by science—is recognized as a paramount, material, and social task. But it is only necessary to study the more recent research work of some of the larger industrial laboratories of the country to learn that this distinction is very far from true. Much of the very best theoretical and apparently impractical work of recent years has come from them.

A nearer approach to a true distinction is arrived at by starting with the premise that research work is only undertaken if it promises to be a good investment. This applies equally to the investigator who is prompted by curiosity and sticks to it for the intellectual gratification he reaps, to the teacher who gets out knowledge of use to him in his profession, and to the industrial organization which increases its dividends.

The difference then between industrial and other research is that industrial research is that kind which is a good investment to an industrial organization. It need not differ at all either in subject matter or in relative attention to theory and practical details from a research in a university, or in a philanthropically endowed institution for public service. It is all a question of the decision of those responsible for the policy of the research laboratory as to where to draw the line between what is a good investment and a bad one. Thus it might be an excellent investment for a commercial laboratory to assign a man for five or six years to the study of a point of theory whose elucidation would facilitate its work, whereas a graduate student in a university, hoping to be through in three years, would consider the same problem, theoretical though it were, as a poor

investment for him. The time is actually here in some branches of science when the development of purely theoretical work (in the narrow sense of the word theoretical) is recognized as a proper investment for the industrial laboratory, and it is surely coming in other branches. Certain phases of theoretical work will, of course, always be practically restricted to the university, and rightly so, but it is of importance to recognize that the university has no monopoly thereby.

It is because research is proving a good industrial investment that the industrial laboratory now offers attractions in the way of facilities and opportunities for work and for public service that seriously compete with the university. How good an investment is, is considered as illustrated by the expenditure of some of the big companies. Thus it is reported that our chief telephone company spends annually on research more than the entire budget of some of our large universities. The chief electrical, oil, steel, and public utility companies spend some hundreds of thousands annually for this purpose. Their laboratories rival those of the government and the foremost universities in facilities and equipment.

The debt of these organizations to the universities for ideals, methods, and men is tremendous. But what must now be recognized is that the university research laboratory has things to learn from industrial research. A characteristic of industrial research of the present day is its definiteness of aim and thoroughness of execution. A whole corps of investigators may be employed on a problem of importance, the attack upon which can be planned like a campaign and carried through to a definite conclusion, even though it takes years and though the personnel of the workers be changed.

A real distinction between much university research and industrial research lies, of course, in the fact that industrial research is definitely aimed toward the solution of problems of practical value to humanity. Much has been written about "science for science's sake," and slurs have been cast on the aims of those who apply science to the improvement of manufacturing processes, or to the amelioration of the material condition of the human race. As a matter of fact it is probable that very few men do research work without the hope and belief that they are thereby contributing to the ultimate material welfare of mankind—let us hope so at any rate. The development of applied science has done more in the last few decades to uplift the whole of mankind and set it free than

have all the other forces at work in the world. A recent writer on the value of scientific work puts it thus:

"It is the only occupation worthy of a man who desires to benefit the world as much as possible by his residence in it." If this be granted, then industrial research can make this claim to merit; that it studies more intelligently the really important problems and attacks them in a more efficient manner than is often done in the universities. The latter are frequently too open to the criticism that they have not kept in touch with the changing needs of industry. Thereby they miss many valuable points of view; their perspective is distorted; they overlook lines of work that are opened up by large scale engineering developments which frequently illuminate in a way that small scale laboratory work cannot. Measurements and studies are often painstakingly made by university laboratories on quantities or methods long since discarded or superseded by the wider angle vision of the laboratory in touch with industrial conditions. In fact it is not too much to say that much university research looks to men in the industrial field as amateurish and poorly aimed.

One more aspect of industrial research may be dwelt upon before the direct bearing of all this on Sigma Xi is considered. Some capital has been made for research in our educational institutions on the ground that their work is not done for selfish ends, but is freely given to the world. As a matter of fact this is a question practically always settled by the individual investigator, though it may claim to be an ideal sometimes adhered to. But this claim of university research to be on a higher moral and social plane than private or industrial work explodes very quickly when considered not as an abstract proposition of good intentions, but in the light of practical conditions. Actually in the vast majority of cases the only way to give anything to the public is through the industries. In the first place the public is almost always ignorant and indifferent. Daguerre for years could interest no one in the photographic process, and more recently the telephone and the half-tone engraving process went begging. It is a characteristic of the inventor to know the value of his work better than anyone else. And it is a blessed dispensation that he usually is endowed with faith and enthusiasm to push and struggle until the public swallows the medicine. In the majority of cases it is quite safe to say that the inventor is far more interested in the success and adoption of his device or

process than in the financial return. The exploitation and development of a new industrial process or machine demands capital. Capital cannot be obtained without the kind of protection that is most wisely intended in our patent laws. No sane manufacturer is likely to bear all the cost of development of an idea if anyone may step in and take advantage of his work at no cost, because that idea has been freely given to the public. Now one of the ideals of research (and of Sigma Xi) is that of service. In many lines of work the real opportunities for an investigator to render real service lie in his attaching himself to an industrial organization which shall be interested and equipped to get his ideas to the public in useful form. In point of actual service rendered to society, the industrial research worker can make today quite as good a claim to recognition as any other worker. Any serious attempt to deny his claim partakes of the nature of snobbery.

The foregoing characterization of industrial research is intended to illustrate how fully are the ideals of Sigma Xi exemplified by it. What, if anything, is Sigma Xi called upon to do?

The relationship of Sigma Xi to industrial research is to be practically determined by the amount of activity and influence the Society feels impelled to exert. It has several alternatives: It might endeavor so to expand its scope as to be a national research society, including in its active membership all men prominently active in research no matter where carried out. What might be the useful function of such a Society? It might definitely restrict its activities to the encouragement of research work in the universities. Is this a valuable activity? Or it might content itself with what has sometimes been its chief function in the past: to offer a purely honorary distinction to the undergraduate who does good work in the sciences, as distinguished from the classics. What can be said for this?

There does exist a field for a national society of research workers. We need in this country unusual aids to what has been termed the cross fertilization of the sciences. Unlike the "tight little isle" which has been the source of such wonderful scientific activity in the past few generations, our scientific institutions and men cannot gravitate to one geographical center. They must be kept informed of each other's work and ideals by artificial means of transportation and communication. Our scientific activities are widespread and specialized. We increasingly need machinery to keep the university man in touch with the industrial man, to keep man, distant from

scientific centers, informed of their work. In each branch of science this need is largely taken care of by the journals of the various scientific societies. But the very important matter of the meaning and aims of scientific research as a whole does not fall within the field of these. There is a real danger in the development of scientific research that the workers will lose, in their specialization, the basic ideas of all sciences. It is an all too common experience to find clever technical men who have no mature ideas outside their own line of work, who appear never to have given a thought to the relation of their work to general scientific principles, or to the general relationship of scientific work to society. It must be sadly admitted too that the training in love of truth which it is the proud claim of science to impart does not always mean that the scientist shall be able to distinguish truth from falsehood in his other human relations. He may be as bad a dupe as the most unscientific when questions of world politics arise. The scientific man needs his philosophy and code of ethics, and there is serious question whether any adequate steps are now taken to help him to them. Sigma Xi might consider assuming as its field the encouragement of mutual acquaintance between scientists in different lines of work but of similar ideals. It might take as its special charge the discussion of these ideals and propaganda for greater attention thereto in the institutions of instruction. A more general recognition of the ultimate aims of science among scientific men themselves—it may with propriety be called more religion—would be a worthy object for a society to strive to promote. The resulting higher standing of scientific work with the public could then be left to take care of itself.

In this connection the writer may be permitted perhaps to remark that such a function could be most practically carried out by a widely circulated journal containing matter calculated to give information on the advance of science of all kinds, interspersed with some philosophy. Such a periodical is *The Scientific Monthly* (formerly *The Popular Science Monthly*). Is the suggestion out of place that such an extension of the Society's activities as just discussed might include the adoption of that journal as the official publication?

The undertaking of such a program—a logical step if the original ideals of the Society as stated are to be adhered to—would, of course, necessitate a revision of the manner of making elections and the customs with respect to chapter and meeting centers. Such

would not be the case with the other alternatives which have been hinted. These may be considered together. Should Sigma Xi be content to be a purely university organization, either as a research society, or as a scientific honor society? From the standpoint that the university is the feeder to the community at large, the fostering of the ideals of research in those who pass through its classrooms is every bit on a par with every other educational influence. It constitutes a legitimate and honorable activity for a society. But to be honest with the world no false implication should be allowed to stand, that research is solely a university specialty, or on a different plane from the research the student is more than apt to engage in after he leaves.

As to Sigma Xi contenting itself with being solely the scientific Phi Beta Kappa, even this is a field not at all unworthy of maintaining. Much may be said with justice against honors and awards for scientific work. They are often, in the nature of things, given by bodies far less fitted to judge of the value of the recipient's (or non-recipient's) work, than he is himself, as a specialist. If the pioneer depended upon his contemporaries' opinions for inspiration or were not ready to continue despite their adverse judgment, he would cease to be a pioneer. Fame and reward drift to a large extent toward those branches of science which are popular, and the social personality of the man chosen for distinction is something of a factor. Now, the point of this comment is that in the award of the Sigma Xi key the student meets probably for the last time a judgment of his capacity by competent judges secured under even sporting conditions. The consequent inspiration and consolation later when conditions are changed may often be a very potent factor in holding him to his path. There is no need to conclude, as some have done, that the Society is useless if its function is restricted to this.

The growth of industrial research may be interpreted as calling for a great extension of the activities of Sigma Xi. A useful field is open for a society which shall knit together all the research activities of the country. At the same time the usefulness of a society frankly restricting itself to the universities is immense. Opinions will differ as to whether there is any call for an extension of these activities. Should not the Society, however, set its house in order? Should it not either expand into the whole research field which it originally claimed as its own, or more strictly define the narrowed boundaries which are, with its present organization, left to it?